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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

NASA-02716 (March 2003)
NASA
Superseding NASA-02716
(September 1999)

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03/03

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NATIONAL AERONAUTICS **NASA**
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SECTION 02716

LIME SOIL STABILIZATION
03/03

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NOTE: Delete, revise, or add to the text in this section to cover project requirements. Notes are for designer information and will not appear in the final project specification.

This section covers lime stabilization of subbases and base courses for airfield pavements, roads, streets, and parking areas.

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: The following references should not be manually edited except to add new references. References not used in the text will automatically be deleted from this section of the project specification.

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The publications listed below form a part of this section to the extent referenced:

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 180	(1997) Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop

ASTM INTERNATIONAL (ASTM)

ASTM C 136	(2001) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C 25	(1995) Standard Test Methods for Chemical Analysis of Limestone, Quicklime, and

	Hydrated Lime
ASTM D 1556	(2000) Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 2027	(1997) Standard Specification for Cutback Asphalt (Medium-Curing Type)
ASTM D 2028	(1997) Standard Specification for Cutback Asphalt (Rapid-Curing Type)
ASTM D 2167	(1994) Standard Test Method for Density and Unit Weight of Soil In-Place by the Rubber Balloon Method
ASTM D 2922	(2001) Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	(1988; R 1993) Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D 3155	(1983) Test Method for Lime Content of Uncured Soil-Lime Mixtures
ASTM D 490	(1992) Standard Specification for Road Tar
ASTM D 977	(1991) Standard Specification for Emulsified Asphalt
ASTM E 11	(2001) Standard Specification for Wire-Cloth and Sieves for Testing Purposes

1.2 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01330 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control. Include a columnar list of appropriate products and tests beneath each submittal description.

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The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES in sufficient detail to show full compliance with the specification:

SD-01 Preconstruction Submittals

Construction Equipment List shall be submitted for approval.

SD-06 Test Reports

Test reports shall be in accordance with the paragraph entitled, "Testing and Approval," of this section, for the following items:

Sieve Analyses of Soil
Sieve Analyses of Soil-Lime Mix
Density Test

SD-07 Certificates

Certificates for Waybills and Delivery Tickets shall be submitted in accordance with parapraph entitled, "Approval of Materials," of this section.

Certificates of compliance shall be submitted for the following items showing conformance with the referenced standards contained within this section:

Cutback Asphalt
Emulsified Asphalt
Tar
Lime
Soil

1.3 QUALITY ASSURANCE

Sampling and testing for quality control shall be the responsibility of the Contractor. Sampling and testing shall be performed by an approved testing laboratory or by the Contractor, subject to approval. Tests shall be performed to ensure that materials and finished product meet specified requirements. Copies of test results shall be furnished.

1.4 APPROVAL OF MATERIALS

Test results shall be submitted by the Contractor not more than [24] [_____] hours after completion. Final approval of material shall be made on the completed course prior to the application of the next course.

[Certificates for Waybills and Delivery Tickets shall be submitted by the Contractor. Job contract number and name, along with a signature of the Contracting Officer shall appear on the delivery tickets.]

1.5 OPERATION OF MATERIAL SOURCES

Clearing, stripping, and excavating involved in the operation of pits or quarries shall be performed by the Contractor. Upon completion of work, pits or quarries on Government property shall be conditioned to drain and be left in an approved condition. Pits or quarries on private lands shall be conditioned in accordance with local laws and authorities.

1.6 CONSTRUCTION EQUIPMENT LIST

Construction equipment list for all major equipment used for transporting, spreading and finishing shall be submitted by the Contracting Officer prior to construction.

PART 2 PRODUCTS

2.1 BITUMINOUS MATERIAL

Cutback Asphalt shall conform to ASTM D 2027 or ASTM D 2028, grade [RC-250] [RC-800] [MC-250] [MC-800].

Emulsified Asphalt shall conform to ASTM D 977, type [RS-1] [RS-2].

Tar shall conform to ASTM D 490, grade [RT-7] [RT-8] [RT-9] [RT-10].

2.2 LIME

Lime shall be a standard brand of [quicklime] [hydrated lime] conforming to the following physical and chemical requirements:

Lime shall be of such gradation that 99-1/2 percent passes a No. 20 850 micrometer sieve and a minimum of 85 percent passes a No. 100 150 micrometer sieve.

Combined calcium oxide and magnesium oxide shall be not less than [92 percent] [70 percent].

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NOTE: Drawings should show the locations of borrow areas if applicable.
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2.3 SOIL

Soil shall consist of the natural material in the areas as indicated, approved select material, or a combination of these materials proportioned as specified. Stones retained on a 3-inch 75 millimeter sieve and deleterious substances such as sticks, debris, and organic matter shall be removed.

2.4 WATER

Water shall be potable.

PART 3 EXECUTION

3.1 TESTING AND APPROVAL

3.1.1 Testing

Laboratory tests required for design purposes and the determination of optimum lime content, optimum water content, and maximum density of the soil-lime mixture will be performed by the Government. Tests required for

quality control of materials and density shall be the responsibility of the Contractor. Tests shall be performed by an approved commercial testing laboratory or by the Contractor. Tests shall be performed in sufficient number to ensure that materials and compaction meet specified requirements. A minimum of one density determination shall be made per 500 square yards 400 square meter of lime-stabilized material. Copies of test results shall be furnished to the Contracting Officer.

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NOTE: In general, when mixed with lime, all fine-grained soils exhibit improved plasticity, workability, and volume change characteristics; however, not all soils exhibit improved strength, stress-strain, and fatigue characteristics. The properties of lime-soil mixtures depend on many variables. The more important are soil type, lime type and percentage, and curing conditions including time, temperature, and moisture content. In addition, the effect produced by any one variable is dependent on the levels of the other variables.

For these reasons, it is mandatory that extensive laboratory investigations be conducted by the Government prior to design so that the pavement structure may be ascertained.

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3.1.2 Control Tests

Sieve analyses shall be made on sieves conforming to ASTM E 11. Lime shall be tested for the specified chemical requirements in accordance with ASTM C 25.

Sieve Analyses of Soil and Sieve Analyses of Soil-Lime Mix shall be made in conformance with ASTM C 136.

Density Test shall be taken in the field in accordance with [ASTM D 1556], [ASTM D 2167], or [ASTM D 2922]. If ASTM D 1556 is used, the base plate as indicated shall be used. If ASTM D 2922 is used, the calibration curves shall be checked and adjusted, if necessary, by the procedure described. Calibration curves furnished with the moisture gages shall also be checked along with density calibration checks as described in ASTM D 3017. Calibration checks of both the density and moisture gages shall be made at the beginning of a job on each different type of material encountered and at intervals as directed. Maximum density at optimum moisture content shall be determined in the laboratory in accordance with AASHTO T 180, Method B or D.

3.2 RATES OF MATERIAL APPLICATIONS AND DENSITY

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NOTE: Density may be increased where required by design conditions.

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Rate of application of lime shall be [_____] percent of the dry weight of the soil. Density of the compacted soil-lime mixture shall be at least 90 percent of the maximum density obtained by the test procedure in AASHTO T 180, Method B or D. Bituminous material for curing shall be uniformly applied at the rate of 0.15 to 0.25 gallon per square yard 0.70 to 1.20 liter per square meter. Exact quantities, which may be varied to suit field conditions, shall be as directed.

3.3 PREPARATION OF AREA TO BE STABILIZED

Area shall be cleared of debris. Area shall be inspected for compaction and shall be capable of withstanding, without displacement, the compaction specified for the soil-lime mixture. Debris and removed, unsuitable, in-place material shall be disposed as specified.

In-place material to be stabilized: Entire area shall be graded to conform to the approximate lines, grades, and cross section prior to being processed. Soft or yielding subgrade areas shall be made stable as directed before construction is begun.

In-place material used as a subbase to receive stabilized course: Soft or yielding spots and ruts or other irregularities in the surface shall be corrected. Material in the affected areas shall be loosened and unsatisfactory material removed. Approved select material shall be added as required. Area shall be shaped to line, grade, and cross section and shall be compacted to the specified density requirements.

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NOTE: Select material must be described by physical properties, soil types, and location. Delete when select material is not required.

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Select material: Sufficient select material shall be stockpiled, windrowed, or spread uniformly to provide the required thickness of the soil-lime layer after compaction. Where in-place mixing is to be accomplished, the soil shall be graded and shaped to the approximate section and grade before processing is undertaken.

3.4 MIXING AND PLACING MATERIALS

3.4.1 Mixed-In-Place Method

3.4.1.1 Preliminary Scarifying and Pulverizing of Soil

Prior to the application of lime, the soil shall be scarified and pulverized as necessary to a sufficient width and depth to obtain a uniform mixture of soil, lime, and water and to form a compacted lime-treated course conforming to the cross section indicated. Scarification shall be carefully controlled so that the subgrade, subbase, or base course beneath the layer to be treated is not disturbed. After being scarified, the loosened soil shall be pulverized, with care being taken to ensure that the depth of pulverizing does not exceed the depth of scarification.

3.4.1.2 Application of Lime

Pulverized material shall be shaped to approximately the cross section indicated. Lime shall be applied to the soil in such a manner and in such quantities that when uniformly mixed with the soil, the specified lime content is obtained and a sufficient quantity of lime-treated soil is produced to construct a compacted lime-treated course conforming to the lines, grades, and cross section indicated. Lime shall be applied in bulk, in a slurry, or from bags. Mechanical spreaders shall be used in applying the bulk lime. Distributors shall be used in applying slurry. If the lime is spread by hand, the bags shall be spotted accurately on the area being stabilized so that when the bags are opened the lime will be dumped and spread uniformly on the area being processed. No equipment except that used in spreading and mixing shall be allowed to pass over the freshly spread lime or slurry.

3.4.1.3 Initial Mixing

Immediately after the lime has been distributed, the lime and soil shall be mixed. Complete mixing is not necessary, but the initial mixing shall be sufficient to alleviate any dusting or wetting of the lime that might occur in the event of wind or rainstorms. This may be accomplished several days in advance of the final application and mixing and will tend to make the soil more workable.

After initial mixing, the mixture shall be lightly rolled with steel-wheeled rollers and allowed to cure for [_____] hours.

3.4.1.4 Water Application and Moist Mixing

After completion of initial mixing and in preparation for final mixing prior to compaction, the moisture content of the mixture shall be determined. Moisture in the mixture following final mixing shall be not less than the specified optimum moisture content based on dry weight of soil and shall exceed the optimum moisture content by not more than 3 percentage points. During final mixing, water (if required) shall be uniformly applied as needed. Water may be added in increments as large as the equipment will permit; however, such increment of water shall be partially incorporated in the mix to avoid concentration of water near the surface. After the last increment of water has been added, mixing shall be continued until the water is uniformly distributed throughout the full depth of the mixture. Particular care shall be taken to ensure satisfactory moisture distribution along the edges of the section.

3.4.2 Central-Plant Method

A central plant may be used to mix the soil, lime, and water on jobs where a select material is required for the lime-treated course. Plant shall be capable of producing a uniform lime-treated mixture at the specified lime and moisture contents. Mixture shall be hauled to the job under protective covers. Subgrade shall be moistened and the mixture placed on the subgrade in a uniform layer with mechanical spreaders. Layer shall be uniform in thickness and surface contour and in such quantity that the completed

layer, after compaction, will conform to the required grade and cross section.

3.4.3 Traveling-Plant Method

A traveling plant may be used for either in-place mixing or for mixing select borrow material, lime, and water for subbase and base-course layers. Traveling plant shall move at a uniform rate of speed and shall accomplish mixing of the materials in one pass. Water and lime shall be delivered from supply trucks or bins at a predetermined rate. Windrow of prepared soil-lime mixture formed by the traveling plant shall be of sufficient size to cover a predetermined width of facility to the indicated compacted thickness.

3.5 LAYER THICKNESS

Layer thickness shall be sufficient to enable uniform mixing and to meet density requirements for full thickness of layer. No layer shall be less than 3 inches 75 millimeter when compacted.

3.6 COMPACTION AND FINISHING

3.6.1 Mixed-In-Place Material

Prior to compaction, the mixture shall be pulverized so that 60 percent of the soil, by dry weight, exclusive of plus No. 4 gravel or stone, will pass a No. 4 4.75 millimeter sieve. Water content of the soil-lime mixture shall be checked and adjusted if required, to obtain a uniform water content for the full depth of layer within the specified limits. Loose material shall then be uniformly compacted to the specified density.

3.6.2 Plant-Mixed, Machine-Laid

Compaction of the mixture shall not begin until the specified curing period is passed and the water content is within the specified range for compaction. Compaction shall continue until the specified density specified is obtained.

Prior to final compaction, the lime content shall be determined in accordance with ASTM D 3155. If the lime content is more than 1/2 percent below that specified, additional lime shall be added and the mixture rescarified and cured as specified.

3.6.3 Final Compaction

During final compaction, the surface shall be moistened, if necessary, and shaped to the required lines, grades, and cross section. In places inaccessible to rollers and finishing and shaping equipment, the mixture shall be compacted with power tampers to the required density and shall be shaped and finished by hand methods. When surface of the course for any reason becomes rough, corrugated, uneven in texture, or traffic-marked prior to completion, such unsatisfactory portions shall be torn up, reworked, or replaced, as directed, at no additional cost to the Government. If portions of the course when laid become water soaked for

any reason, that portion shall be torn up at once and aerated until the water content is reduced to within the specified limits and then reshaped and compacted as specified above.

3.7 CONSTRUCTION JOINTS

At the end of each phase of construction, a straight transverse construction joint shall be formed by cutting back into the completed work to form a true vertical face free of loose or shattered material. Material along construction joints not properly compacted shall be removed and replaced with soil-lime mixture that is mixed, moistened, and compacted in accordance with this specification.

3.8 EDGES OF STABILIZED COURSE

Approved material shall be placed along the edges of the stabilized course in quantities that will compact to the thickness of the course being constructed or, when the course is being constructed in two or more layers, to the thickness of each layer of the course, allowing in each operation at least a 1-foot 300 millimeter width of the shoulder to be rolled and compacted simultaneously with the rolling and compacting of each layer of the stabilized course.

3.9 SMOOTHNESS TEST

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NOTE: For subbase stabilization this paragraph must be deleted.

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Surface of a stabilized layer shall show no deviations in excess of 3/8 inch 10 millimeter when tested with a [10] [12]-foot [3100] [3700] millimeter straightedge applied parallel with the centerline of the area to be paved. Any deviation in excess of this amount shall be corrected by the Contractor by removing material, replacing with new material, or reworking existing material and compacting, as directed.

3.10 THICKNESS CONTROL

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NOTE: When subbase and base courses are constructed less than 6 inches 150 millimeter in total thickness, a deficiency of 1/2 inch 13 millimeter in the thickness of any area of such paving is considered excessive. Applicable to job conditions, the thickness tolerance provisions may therefore be modified as required restricting deficiencies to not over 1/4 inch 7 millimeter.

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Completed thicknesses of the stabilized course shall be within plus or minus 1/2 inch 13 millimeter of the thicknesses indicated. Thickness of the stabilized course shall be measured at intervals of at least one depth measurement for each 500 square yards 400 square meter of stabilized course.

Depth measurement shall be made by test holes at least 3 inches 75 millimeter in diameter through the stabilized course. Where the measured thickness of the stabilized course is more than 1/2 inch 13 millimeter deficient in thickness, the Contractor shall correct such areas at no additional expense to the Government by scarifying, adding mixture of proper gradation, reblading, and recompacting as directed. Where the measured thickness of the stabilized course is more than 1/2 inch 13 millimeter thicker than that indicated, it shall be considered as conforming with the specified thickness requirement plus 1/2 inch. 13 millimeter. Average job thickness shall be the average of the job measurements determined as specified above but shall be within 1/4 inch 7 millimeter of the thickness indicated.

3.11 CURING, PROTECTION, AND COVER

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NOTE: It may be advantageous to specify only bituminous curing for pavements that are to receive bituminous surfacing under the contract, in which case moist curing specified in paragraph entitled, "Moist Curing," will be deleted and the first sentence in paragraph entitled, "Curing, Protection, and Cover" will be modified accordingly.

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Immediately after the soil-lime area has been finished as specified above, the surface shall be protected against rapid drying for 7 days by one of the methods specified below. Stabilized area shall be protected from freezing during curing period or until hardened, whichever is longer.

3.11.1 Moist Curing

Area shall be moistened by sprinkling and shall be kept moist for the 7-day curing period.

3.11.2 Bituminous Material

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NOTE: The application temperatures shall be selected from the following table and inserted in the blanks. (This table will not appear in the project specification.)

Material	**Degrees F**
Cutback Asphalt:	
RC-250, MC-250	**145 to 222**
RC-800, MC-800	**180 to 255**
Emulsified Asphalt:	
RS-1	**75 to 130**
RS-2	**110 to 160**

Tar:

RT-7 ..... 150 to 225
RT-8..... 150 to 225
RT-9..... 150 to 225
RT-10..... 175 to 250

Material	**Degrees C**
Cutback Asphalt:	
RC-250, MC-250	**63 to 106**
RC-800, MC-800	**82 to 124**
Emulsified Asphalt:	
RS-1	**.24 to 54**
RS-2	**43 to 71**
Tar:	
RT-7	**66 to 107**
RT-8	**66 to 107**
RT-9	**66 to 107**
RT-10	**79 to 121**

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Bituminous material shall be uniformly applied by means of a bituminous distributor at a temperature of [_____] to [_____] degrees F. degrees C. Areas inaccessible to or missed by the distributor shall be properly treated, using the manually operated hose attachment. When stabilization consists of more than one layer, the bituminous material shall be applied only to the top layer. At the time the bituminous material is applied, the surface of the area shall be free of loose and foreign matter and shall contain sufficient moisture to prevent excessive penetration of the bituminous material. When necessary, the area shall be sprinkled immediately before the bituminous material is applied. Contractor shall protect the bituminous material from being picked up by traffic by either sanding or dusting the treated surface.

3.12 TRAFFIC

Completed portions of the lime-treated soil may be opened immediately to light, local traffic, providing the curing membrane is not impaired and to all other traffic after the curing period has elapsed, provided that the stabilized course has hardened sufficiently to prevent marring or distorting of the surface by equipment or traffic. Heavy equipment shall not be permitted on the area during the curing period. However, the necessary lime and water may be hauled over the completed area with pneumatic-tired equipment with approval. Finished portions of lime-stabilized soil that are traveled on by equipment used in constructing an adjoining section shall be protected in a manner that will prevent

marring or damaging the completed work.

3.13 MAINTENANCE

Stabilized area shall be maintained in a satisfactory condition until the completed work is accepted. Maintenance shall include immediate repairs of any defects that may occur either before or after the lime is applied and shall be repeated as often as may be necessary to keep the area continuously intact. Defects shall be corrected by removing defective material and replacing with new material or by scarifying, adding mixture of proper gradation, reblading, and recompacting as directed at no additional cost to the Government. Repairs shall be made in a manner that will provide a uniform surface.

3.14 DISPOSAL OF UNSUITABLE MATERIALS

Removed in-place materials that are determined unsuitable for stabilization, material that is removed for the required correction of defective areas, waste material, and debris shall be disposed of as directed by the Contracting Officer.

-- End of Section --